NATIONAL BANK OF SCOTLAND-
A 3D STUDY

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National Bank of Scotland - A 3D Study

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Stage 5 (DipArch)
April 2008

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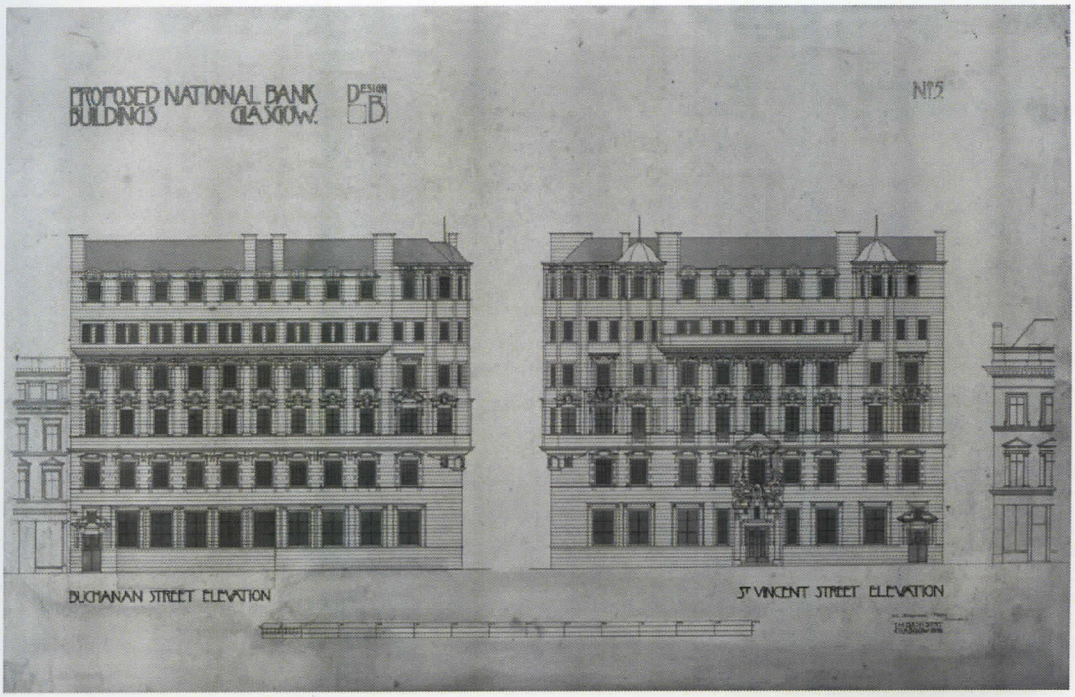
[1] Final greyscale render with National Bank of Scotland highlighted – C Green



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[2] Mackintosh Design 1898 - The Hunterian Museum and Art Gallery

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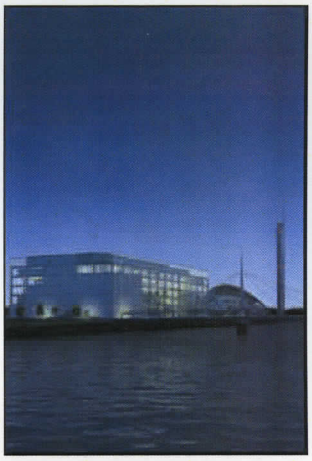
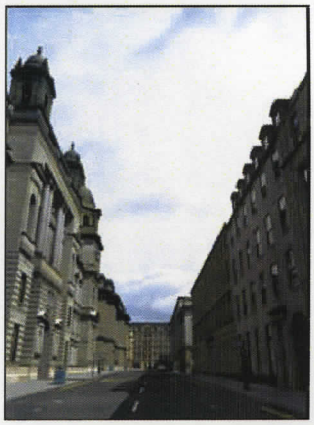
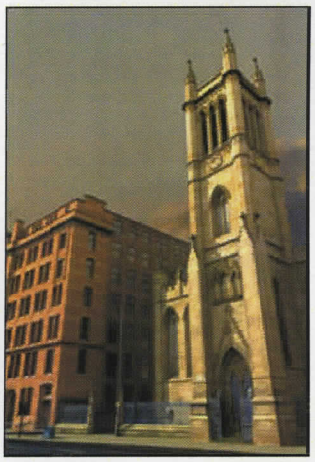






[3]

[3] Glasgow City Model, Renders – Digital Design Studio

Part 1

Introduction -

In this dissertation I intend to document how the integration of 3D modelling into the urban development/planning process allows a greater level of detail in the visualisation of planned building projects. Consistent visualisations can be produced of competition entries, for example the terrain and immediate site information.

This will free up modelling time for the architects, as the immediate site information will be provided in a 3D environment. The use of a 3D site model will help to speed up the planning process because a 3D model will show clearly all the details that would be of interest to the planning department. E.g. building heights, colours/materials used, lighting levels etc.

With an accurate site model there can be no grey areas within the design. These can occur when more traditional methods are used e.g. perspective drawings, which show, an ideal but impractical view, or inaccurate site context within a computer rendering. The design can be explored fully in 3D from all angles.

With 3D computer modelling you are able to accurately compare different designs in order to see how they will truly sit within a particular site and what effects they have on their immediate surroundings. New buildings can be tested with different materials, colours & textures, in order to see the effect on the building itself, as well as on its surroundings.

Competition entries can be tested against each other, thus allowing planners to get an accurate representation of new buildings before any work begins. The 'City Model' can also be used to realise buildings which have long since been destroyed or currently lie in ruin.

As an example of this process, I have chosen an unsuccessful competition entry by Charles Rennie Mackintosh as the basis of a model. An unrealised design which can be created in 3D to highlight some of the benefits 3D modelling can give to architects.

I intend to research Mackintosh's unsuccessful competition design; a design for which there is very little information available documenting it. I will look at the potential benefits of 3D modelling and will describe alternative procedures that could be considered. For example, alternatives to the 'City Model' as well as different approaches to the modelling process.

I intend as part of this dissertation to describe the process of creating a 3D model as follows:

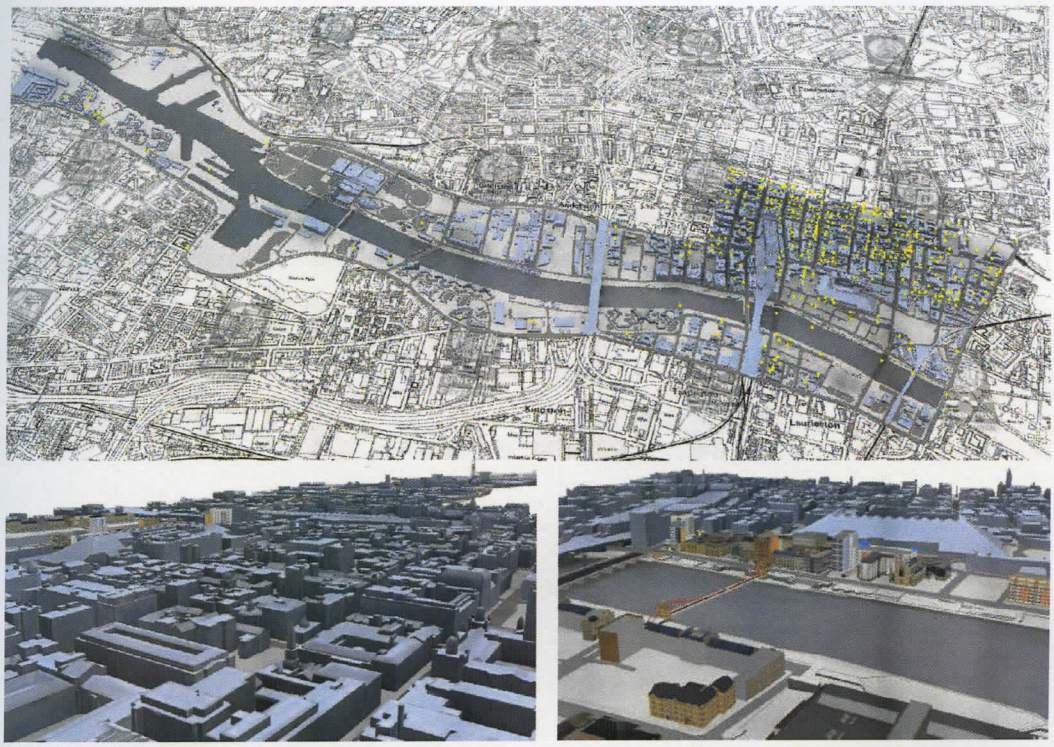
- Trace a jpeg image in AutoCAD
- Import AutoCAD file (.dwg) into 3DS Max
- Build 3D Model and texture
- Export 3D Model into the 'City Model'
- Render model within its surroundings

Mackintosh's unsuccessful competition entry for the National Bank of Scotland has been chosen for a number of reasons. Firstly the location sits within the current boundary of the 'Glasgow City Model'. At the moment, the model covers the immediate streets to the north and south of the river Clyde. In the future the model will be increased to include most of central Glasgow.

Secondly, Mackintosh's alternative competition entry provides significant change to the existing building that it will be a useful example in illustrating how the use of 'city models' can help with the planning process. With 3D computer modelling I will be able to accurately compare Mackintosh's design with the winning design, in order to see how it will truly sit within a particular site and what effects the new design will have on its immediate surroundings compared to that of the winning design. Finally, Mackintosh's proposal can be tested with different materials, colours & textures, in order to see the effect on the building itself, as well as its surroundings.

I intend to research and document Mackintosh's unsuccessful competition entry, as well as the process by which one could create a 3D model of the design; and place that completed model into a 'city model.'

Below is the low detail 'blue foam' model created by the Digital Design Studio. The model shows the rooftops and massing of buildings on the north and south of the river Clyde accurately in 3D.



[4]

[4] 3D 'Blue Foam' City Model - www.glasgow.gov.uk – Digital Design Studio

Glasgow City Model –

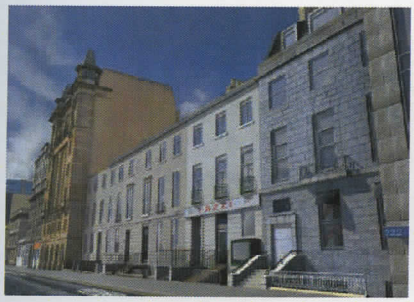
The 'Glasgow City Model' which has been built by the Digital Design Studio (on behalf of Glasgow City Council) at the Glasgow School of Art, will prove to be a useful tool to aid architects, and planners as well as a method in gaining public opinion on new design proposals.

"*Improve the participation and consultation process for future development proposals in the city.*" [5]

There are also other potential model uses, for example, by the police for crowd control procedures, anti-terrorism measures or by stone preservation societies as a record of condition of the cities stonework. The model and images produced will serve as a historical record of Glasgow 2007.

Below is a statement from the DDS website outlining the project and example renders of the 'City Model':

"*The Digital Design Studio and Mackintosh School of Architecture beat off the competition to win a tender to provide the city of Glasgow with a highly-detailed, photorealistic 3D model of the City. A website application will allow tourists and citizens to explore the city from their computer. The model will also be used by the Council for assessing planning proposals and visualising design alternatives as well as helping citizens make informed decisions about what is best for their community.*" [6]



[7]

[5] Glasgow Urban Model - www.glasgow.gov.uk
[6] From the Digital Design School website - www.gsa.ac.uk
[7] Glasgow City Model Renders of Clyde Street & Bridge Street – Digital Design Studio

I intend to document the National Bank of Scotland competition. In particular the style Mackintosh chose to adopt and the stage in his career when it was designed, and why the winning design was chosen over Mackintosh's design. I will look at the similarities and differences in the designs and their relative successes and failures. With a completed 3D model I will also compare material choice on Mackintosh's design; what effect it may have on the surrounding buildings as well as the impact it will have on the streets around it.

I will outline how the building sits within a modern Glasgow, one in which most buildings of its age will have been altered to accommodate new functions, and will have aged through weathering and pollution.

Finally the choice of a Mackintosh design was in part chosen because, as has been seen with the House for an Art Lover, – a winning competition entry that wasn't built until 1996 – there is a real appetite from the public for all things Mackintosh. More so than designs by other architects, therefore it is more likely that, an unrealised design by Mackintosh could be built one day.

National Bank of Scotland -

[8]

The National Bank of Scotland is located on the corner of St Vincent & Buchanan Street in the centre on Glasgow. Today it houses a branch of the Bank of Scotland as well as several small retail units on Buchanan Street. The upper floors contain office space owned by different companies available for let. However, the very fact that the building has office space available for let indicates the change in needs of a modern day bank. Less office space is needed, due to changes in technology e.g. all records bring kept on computer rather than on paper. There is also no longer the same desire on behalf of a bank to convey their wealth with lavish banking halls and premises. Instead the focus is more on brand identity, in particular branch colours and company logos.

The design of the building was to be decided by a contest organised by the National Bank of Scotland's directors. In the October of 1898, seven pre-selected architects were

[8] National Bank of Scotland today

sent a letter by the directors of the bank inviting them to submit designs for the new building. Those architects and practices invited to submit designs included; Charles Rennie Mackintosh, Honeyman & Keppie, John Burnet & Son, Peddie & Browne and Sydney Mitchell & Wilson. In some cases the design was submitted by the practice rather than the individual. Mackintosh however, submitted a separate design to Honeyman & Keppie, for whom he was working at the time.

The design was to include suitable bank accommodation as well as lettable retail space on Buchanan Street. It was however, left up to the individual architects to decide on which street to have the bank's main entrance. This was also the case with the overall height of the building. The bank directors had quite specific ideas how the bank should sell itself, as they felt the location to be one of the most important in the centre of Glasgow. It is quite apparent from the competition letter that the directors of the bank probably had a design/style in mind in advance of the submissions.

"My Directors do not favour the idea of anything of the nature of elaborate decoration of the external part of the building, and have expressed a leaning towards a thoroughly businesslike building of the highest class and of chaste design…Meantime I would only add that the site referred to is one of the most important in the centre of Glasgow." [9]

It is also interesting to note that the directors pre-selected the architects and practices for design submissions. This would indicate that they were familiar with the practices/architects respective work and clearly liked what had been done previously.

All of the design submissions were to be, un-coloured and to include approximate costs of the building. The fact that the drawings where to be un-coloured is quite interesting as this would suggest that the directors had a material in mind. Each architect who submitted a design was given an honorarium (a free gift of money as reward) of 100 guineas, with deadline for submission being only two months, to the end of the year 1898.

From the competition design letter issued to all practices:

[9] Competition Letter, 13 October 1898

"Should you see your way to accept this invitation, I may mention for your guidance the following main points which my Directors have in view. The utilization of the site to the best possible advantage for the purpose of providing (a) the most complete and approved office accommodation for the Bank's business, including vault and safe accommodation, without any unnecessary waste of valuable ground floor space; and (b) lettable shops and offices of the highest class, thoroughly lighted and ventilated, and provided with all the last modern conveniences and appliances in the matter of hoists and suchlike. Special attention should be given to the question of the rental to be obtained from these portions of the premises which may be let." [10]

[10] Competition Letter, 13 October 1898

Winning Design -

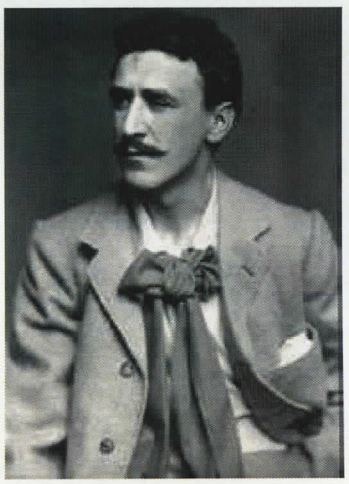
The winning scheme was designed by the Edinburgh based practice of Peddie & Browne, a short lived, but highly successful practice which operated from 1895 to 1907, mainly, but not exclusively in the East of Scotland and Borders regions. They had, in the previous and subsequent years designed many branches of the British Linen Bank. As a result they had developed a successful track record in that field, and would have been familiar with many of the requirements needed within a bank. Work began on the new bank in 1899 after a tender for £47,000 (approx) was accepted.

The building remains in good condition today and in 1970 was granted B listed status. At the time of writing the building houses a branch of the Bank of Scotland, Post Office as well as two mobile phone outlets. The focus of the building is very much on Buchanan Street rather than St Vincent Street due to the fact that in the intervening years since it was built Buchanan Street has become a successful pedestrian shopping precinct. At the time of the competition Buchanan Street and St Vincent Street would have been of equal importance. St Vincent Street ran east to the Merchant City (the business centre at the time) and west to Charing Cross. Buchanan Street ran north to the intersection with Sauchiehall Street and south to St Enoch station.

[11]

[11] Photographs of the National Bank of Scotland 1901 - RCAHMS

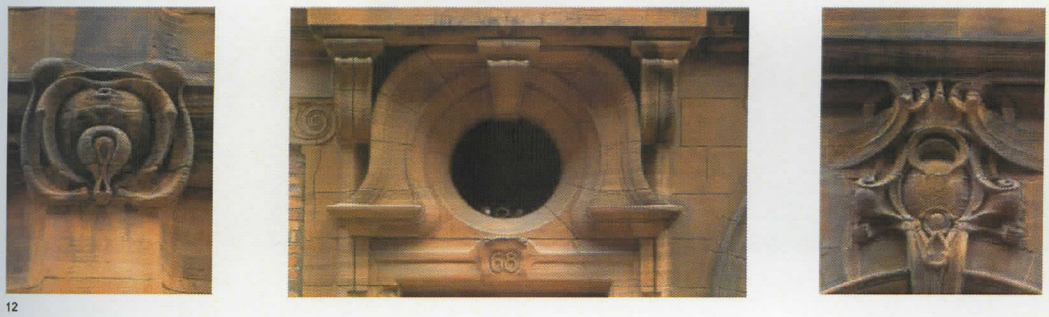
Mackintosh Design –



Mackintosh's design for the National Bank of Scotland came relatively early is his architectural career. He joined the architectural practice of Honeyman & Keppie as a draughtsman in 1889 from John Hutchinson's practice where he had been an apprentice. By 1896 he had become a senior assistant, and by 1901 had become a partner in the practice; a position which he held for twelve years.

At the time of the competition he had been involved in several important projects. Most well known of these was his winning competition design in 1896/87 for the Glasgow School of Art. His design for the National Bank of Scotland is on the other hand relatively unknown, with very little written about it. In fact it is unlikely that had Mackintosh not gone on to become quite so famous and internationally renowned that the competition drawing would have been retained. However it has been and it is now housed along with much of his work in the Hunterian Museum & Art Gallery at Glasgow University, which sits roughly where Mackintosh and his wife used to live.

In the years prior to the National Bank of Scotland design Mackintosh had been involved in the design of the Glasgow Herald Building 1894, and Martyr's Public School 1895. However it is not clear what level of involvement he actually had in either of these projects. However what is clear is that several characteristics are shared with those of his later works. This is particularly the case with regard to some of the organic detailing which appears on the tower and upper levels of the Glasgow Herald Building, many of which are similar to those which appear on the National Bank of Scotland design.



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"...the upper level of the Glasgow Herald Building where Mackintosh was allowed some freedom to express himself." [13]

His design for the National Bank of Scotland is quite a departure from his other works. It is much more classical in design when compared to the more modernist/art nouveau designs he is famous for. The differences in style can be seen quite clearly when comparing it to his house designs at Windyhill and Hillhouse, or his commercial projects like the Willow Tea Rooms or the Daily Record Building.

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The common feature seem throughout his career are organic details on the façade.

"*In all of his design there is a personal touch combined with the heritage of the Scottish tradition...Mackintosh worked personally on all of the decorative features.*" [15]

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[12] Glasgow Herald Building Details, similar to those seen on the National Bank Design - Archipockets Classics, teNeues Publishing UK 2002
[13] Charles Rennie Mackintosh & Co 1854 to 2004, David Stark, Stenlake Publishing
[14] Windyhill Kilmacolm, Willow Tea Rooms Buchanan Street & Hillhouse Helensburgh
[15] Charles Rennie Mackintosh, Archipockets Classics, teNeues Publishing UK 2002

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On the competition drawings for the National Bank of Scotland we can see that even though he opts for more traditional classical rules for the façade, he incorporates his own design details, particularly around the upper stories.

It was perhaps because of this reason, that he didn't win the competition. The detailing is maybe a little too ornate for the banks directors, who were not overly keen on elaborate decoration[17]. However when you look at the winning design it also has a certain level of elaborate decoration, but it is much more in keeping with the style of other buildings of the time. In particular, the banks, offices and warehouses in the Merchant City; which lie to the east of Buchanan Street. Other differences worth mentioning are the different locations of the entrances to the building. The Peddie & Browne design has a clear symmetry on both facades, whereas Mackintosh's design is asymmetrical on both. On the winning design there is a central doorway in the middle of the façade, as well as more obvious retail spaces on either side. - It should be noted that alterations were made to the lower retail level of the Buchanan Street façade in 1985. - Mackintosh's design is also one storey higher than the winning design. This increase in height may not have suited the bank's directors, it was perhaps one storey too many.

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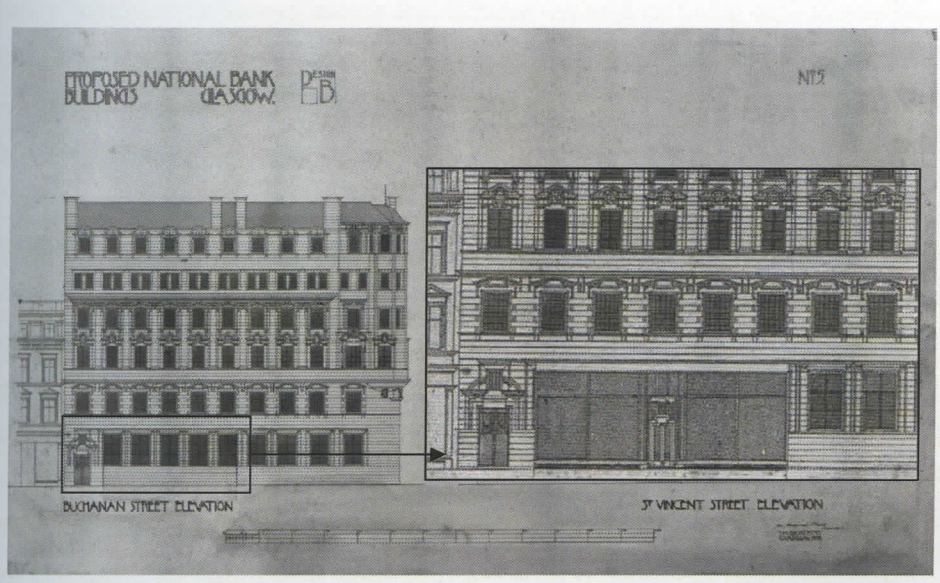
[16] Queen's Cross Church Details, Archipockets Classics, teNeues Publishing UK 2002
[17] Competition Letter, 13 October 1898
[18] Glasgow Herald Building, Daily Record Building & Glasgow School of Art

"The height to which the building should be carried is also a point regarding which my Directors are prepared to consider suggestions" [19]

Alternative Façade –

Included on Mackintosh's competition drawings is an alternative lower level retail elevation. A flap on the Buchanan Street elevation reveals a glass frontage very similar to those seen in shop fronts today. It is not clear however if Mackintosh wanted this feature to run the length of the façade or only half way along.



[20]

This might be seen as an element of indecision on Mackintosh's part; however it is ultimately an interesting alternative take on the design that will allow comparisons to be made between each through the use of the 3D model. There is clearly also a different feeling created by an open ground floor; a business with a glazed front will be more inviting to customers when compared to a doorway straight off a busy street.

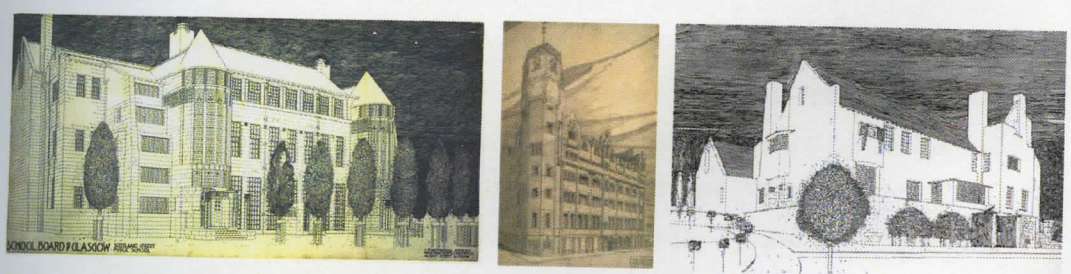
[19] Competition Letter, 13 October 1898
[20] Alternative Façade on Buchanan Street, Mackintosh Drawing & 3D Model Façade Renders

"When Mackintosh designed a main-street frontage in the commercial centre of Glasgow for the National Bank of Scotland, he produced a free classic façade decorated with some elaboration." [21]

3D Model -

It is because of the differences between the winning design and Mackintosh's design that I am attempting, with 3D modelling software to visualise the building if it had won the competition and been built. By recreating Mackintosh's design I will be able to comment on each designs relative successes and failures, as well as being able to see the effect each building has on its surroundings, with regards overall height and therefore its presence on the street, the choice of materials used and natural lighting levels both within the building and on the street.

With the clear similarities in design with the Glasgow Herald Building, I would expect that it was to have been made of red sandstone. This may not have been the case, but because the drawings are uncoloured and there are no accompanying notes which describe for sure what materials were intended to be used, therefore an educated guess has to be made. However it is more than likely that sandstone would have been used. The horizontal lines on Mackintosh's drawing suggest that it would have been sandstone rather than brick due to the size between them. In other Mackintosh drawings which were built out of sandstone the same drawing style is used. For example,



[22]

[21] Charles Rennie Mackintosh – Edited by Wendy Kaplan – Abbeville Press 1996
[22] Mackintosh's perspective drawings of, Scotland Street School, The Glasgow Herald Building and Hill House -The Hunterian Museum and Art Gallery

Mackintosh's perspective drawings of: Scotland Street School, the Glasgow Herald building and his elevations of the School of Art, all are made from sandstone and have been drawn the same way. We can also rule out a rendered surface - which became a feature on many of Mackintosh's housing designs - due to the fact that for buildings which were to have a rendered surface, Mackintosh drew no horizontal lines on the façade, for example his house designs Windyhill, and Hill House as well as the Willow Tea Rooms.

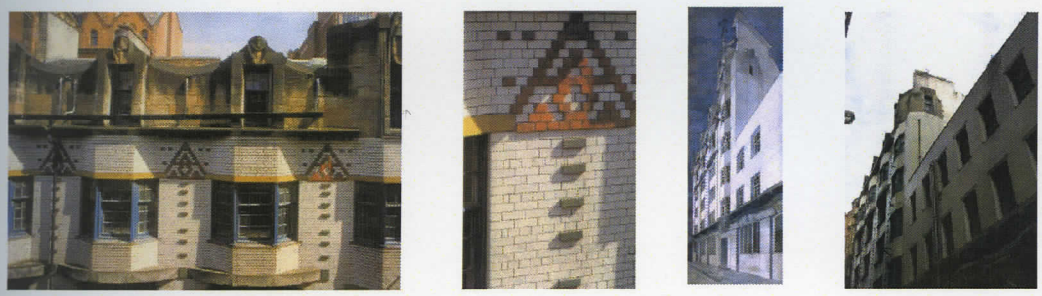
The choice of sandstone colour would have been decided by Mackintosh, it is likely to have been either red or yellow/cream in colour. This difference would make it visually quite different to the winning design as the Peddie & Browne design is built mainly from Plean sandstone which is light yellow/cream in colour. Interestingly the same stone was used on another National Bank of Scotland in the Trongate; Merchant City in 1901, which might suggest that there is an element of corporate identity going on with, regards material choice. Red sandstone in Glasgow started to appear more into the earlier 20th century due to the reduction in available local cream sandstone.

"Appearance of red sandstone as the chief building material, replacing the white sandstone of the local quarries which was becoming exhausted. Red sandstone was brought by rail from Ayrshire and Dumfriesshire." [23]

Another unknown factor with the design is the roof plan. There are a few clues from the elevations, but they only describe a small proportion of the roof area. From the 3D 'Blue Model' produced by the DDS; it can be seen that the Peddie & Browne design was L-shaped in plan. It is likely that Mackintosh would have done something similar as a square plan would have made getting natural light into the building rather difficult. In a smoke/soot filled city, which Glasgow was at the time, getting natural light into a building would have been vital. On other Mackintosh designs such as the School of Art and Scotland Street School we see facades dominated by large windows. On the Daily Record Building we can see similar features on both façades. Both buildings sit within a similar city centre context. However the Daily Record Building is rectangular in plan, and doesn't occupy a corner situation. Instead it overlooks a six metre wide lane. Mackintosh's treatment of this scenario should provide clues as to how he would have

[23] The Tenement – Frank Worsdall – W & R Chambers 1979

dealt with the rear of the Bank of Scotland which faces onto the small lane off St Vincent Street.



[24]

Finally there are a couple of features on the elevations which are not completely explained without the plan. Again, judgement based on Mackintosh's previous works should help to explain how they might have been built. This is particularly the case with the turrets on the St Vincent Street façade which may be similar to those seen on the Glasgow School of Art and Daily Record Buildings. The rear façade of that building might also suggest Mackintosh's plan for the third façade of the National Bank of Scotland Building. The designs of the window and door architraves are similar to those on the upper levels of the Glasgow Herald Building which will assist in determining depth and detail in the design.

[24] Daily Record Building, Renfield Lane, Glasgow - Archipockets Classics, teNeues Publishing UK 2002

Part 2

The 3D City Model

Detailed 3D models have, in recent years, started to see widespread use. This is in part due to increased computing power, but primarily to the emergence of virtual mapping software such as Google Earth, NASA's World Wind and Microsoft Virtual Earth. This has been made possible by the increased availability of satellite images of the Earth's surface (and in the most recent version of Google Earth, of other planets as well).

In order to collect the data required to digitize a city a variety of methods need to be introduced. Aerial photography/aerial laser scanning - from an aeroplane flying above the city - ground level photography/ground level laser scanning and auxiliary mapping data such as topographic data. At the Digital Design Studio they used a combination of aerial scanning to get accurate representations of the roof structure of buildings. This method can be seen clearly on the '3D blue foam' model of Glasgow.

[25]

Collecting this data at ground level would be virtually impossible. They also made use of ground level lasers which accurately scan and record buildings in 3D. The scanner is set up at various points around a building and fires beams of light at the building which are bounced back, similar to radar/sonar devices or a normal flatbed office scanner. The information collected creates a 3D image of the building comprised of a series of dots. This data is then refined in 3DS Max in order to create the building in 3D. High resolution photographs are taken of the building, which are then used to create textures which can then be applied to the building's various surfaces.

[25] 3D 'Blue Foam' City Model - www.glasgow.gov.uk – Digital Design Studio

Potential Uses -

"The integration of 3D city modelling into the urban development process allows a higher degree of realism in the visualization of planned buildings and projects. For example, more consistent visualization can be produced in architectural tender projects, since the basic 3D geometry – the areas surrounding the project site and the digital terrain – is the same for all bidding companies. Thus the decision making process and public involvement can be improved."[26]

City models can be used for a variety of purposes, ranging from planning applications to security and defence measures to solar studies.

Potential uses for 'City Models':

Urban Infrastructure

- 3D visualization for city planning, city-related decision making.
- 3D visualization for presentations and public displays.
- Geo-referenced search capabilities for locations and/or location related information. E.g. Google Earth
- Precise measurements of distance, surfaces and volumes throughout the 3D-model.
- Seamless integration with customized tools and databases such as CAD
- Analysis of traffic flow, pedestrian patterns and land use.

Tourism & Travel

- Integration with tourist attractions and information kiosks.
- Virtual tours for trip planning and familiarization with places of interests.
- Integration with custom 3D indoor models for tourism related locations (such as museums, galleries, hotels, restaurants etc.).

Policing

- Applications for planning, managing, monitoring, training and simulation of security-related scenarios such as special events, emergency planning, and crime scenario mapping.
- Location-based search capabilities for security /defence related locations.
- Customised training and building scenarios based upon the city model.

Entertainment

- Local and remote controlled navigation at four levels: walking, driving, hovering, or flying.
- Location-based search capabilities.
- Customized information related to sites, buildings and businesses.
- Integration of geo-referenced entertainment content and 3D human interaction (social networking).

[26] Detailed 3d city models provide new perspectives on urban development – Jesper Rye Rasmussen , Architect, Blominfo.dk

Historic

- Recreation of buildings which are in ruin or have been demolished.
- As a record of a buildings condition, e.g. stonework, window frames etc

Architectural Design

- Sun Studies, daylight levels and shadows.
- Acoustic testing of locations within the city.
- Design comparisons
- Material selection based on site location and conditions
- Landscaping [27]

[27] http://www.geosim.co.il/sol_municipalities.htm

National Bank of Scotland

With a completed 3D model of Charles Rennie Mackintosh's National Bank of Scotland, I intend to replace the existing Bank of Scotland model in the Glasgow 'City Model'.

- I will research the effects of a sun study, and compare the differences on both models. E.g. shadow levels at street level.
- I will look specifically at Mackintosh's design and compare the choice of sandstone, and look at the how different colours effect the appearance of the building. Will red sandstone for example, be more imposing when compared to a lighter yellow/cream colour?
- I will research the potential benefits of this process, what can be learned from viewing different designs in 3D? In particular I will compare the heights of each building, would Mackintosh's design have been too large. If yes, what effect does this have on its surroundings? Is it any more or less ornate than Peddie & Browne's design?
- I will compare the effects of weathering on the building. Does Mackintosh's clean design look out of place when compared to the original design which has been in place for over a hundred years, and has therefore been altered to adhere to modern building requirements and regulations?
- Finally I will discuss the benefits of an expensive city model when compared to a simpler alternative, Google Earth. Does the increased detail give a greater accuracy or understanding of the design, or as a method of comparing designs?

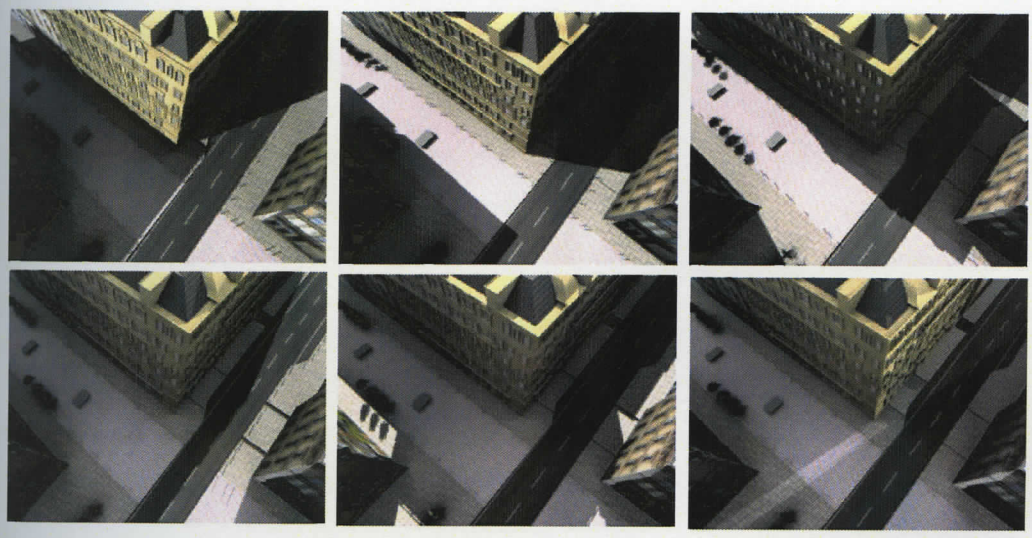
[28]

[28] Final Render – National Bank of Scotland – C Green

Sun Study –

The sun study at the bottom of the page shows the change in shadows over an average day in August at two hour intervals. With a 3D model, the light and shadow levels can be observed at any time throughout the year with a variety of lighting conditions.

When comparing Mackintosh's design to the Peddie & Wilson one; the only difference in terms of lighting levels between the two is that Mackintosh's design, being a story taller, creates a longer shadow. The effect at street level would therefore have been minimal.



[29]

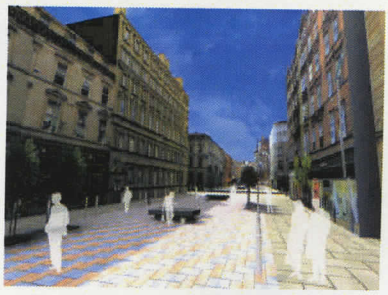
During the design process a sun study can be used on relatively low detail models to determine its effect on street level. On more advanced models various tests can deduce the levels of natural daylight that enter through a particular window say, or to what extent a new building puts its neighbouring buildings in the shade. This level of research could not be achieved to the same levels of accuracy when compared with traditional hand built scale models, and therefore gives architects more definitive data when it comes to making judgements on lighting design.

[29] Sun Study – August 21st - 9am, 11am, 1pm, 3pm, 5pm & 7pm.

Colour –

By creating the National Bank of Scotland in 3D, one of the variations I can test is the choice of materials in particular the colour of sandstone chosen. With Mackintosh's design we can only guess as to which colour would have been chosen, however with the 3D model both colours can be applied to see the different effects colour has on the building itself and the surrounding buildings and streets.

The images on the right illustrate how a 3D model can be used to compare colour choice. The cream sandstone fits in better with the buildings beside it due to their use of the same stone. The red sandstone however is much more striking, due to the vibrant nature of the colour; it is much more dominant than the cream sandstone on the corner site.



By comparing both colours I think either could have been chosen, and neither would have looked out of place. I suspect however due to the fact that the winning design was built with cream sandstone, then so would Mackintosh's, probably on the demands of the Bank's owners.

This exercise does highlight the difference to a building a variation in colour can make. If the buildings around a design are predominately the same colour then a complete departure with regards colour in your design will make a design stand out, and potentially more dominant. On the other hand a more subtle colour could be used in order to recede a building, particularly in more sensitive or historical sites.

The advantage of a 3D model is that variations in colour, texture and material can be tested quickly and efficiently when compared to traditional methods of drawing or modelling.

[30]

[30] Final Renders showing the different colours of sandstone – C Green

Design Subtleties –

Along with testing different colours, a 3D model allows one to test relatively quickly design subtleties, such as the position and style windows and doors. In the case of the National Bank of Scotland, Mackintosh, on his competition drawings provided an alternative façade design on Buchanan Street. By using a 3D Model both options can be modelled and then compared.

[31]

The images above illustrate the two versions of Mackintosh's façade design. On the left we see the glazed full height shop front, on the right the windowed façade as seen on the St Vincent Street.

The full height glazed design is much more modern in its appearance, like many of the shop fronts on Buchanan and Sauchiehall Streets. The design on the right is much more traditional in its appearance and would be more suited to a non-retail street as the design doesn't encourage window dressing and is less inviting.

This is a prime example of the benefits of 3D modelling as both designs can be compared in exactly the same conditions. In this example, light studies could be undertaken to determine how much additional daylight may enter the space. It will also help to save the Architect time as it is a fairly routine alteration to make. Comparisons can therefore be made quickly during the design process.

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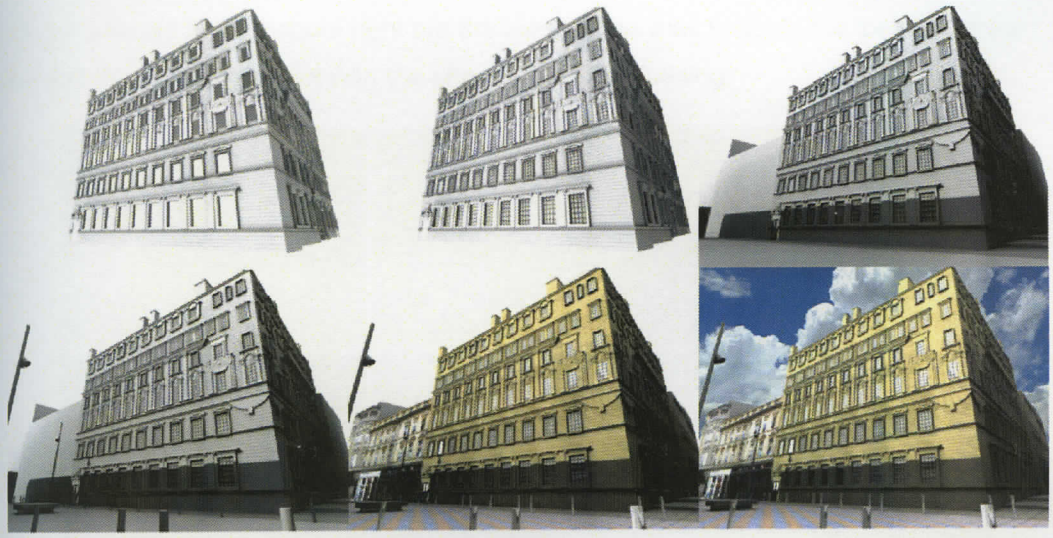
[31] 3D Renders of the National Bank of Scotland, showing facades differences – C Green

Levels of Detail –

One of the potential benefits of a 3D model is the ability to strip the model back to more basic levels. For example below we can see from left to right, the outer façade of the building to the inclusion of windows. Next we see the street and other building mass; then the inclusion of street furniture, and the textured model without the sky, and finally the model with the sky in place.



[32]

This process of layering the different model elements allows for the model to be studied and observed at different levels of detail and context. An example would be that the first image shows only the façade thus allowing the architect to see his/her drawing realised in 3D. Increasing the context allows the model to be viewed in more realistic terms, at this point the architect can see how their design fits within the site and are therefore able to make alterations if needed. The final views show the effect of colour and material on the model, at this point final design considerations can be made, such a colour and texture of materials.

[32] Image showing the increasing number of model layers – C Green

Choice of Sky –

Just as in real life the type of sky effects how one perceives a building, an overcast rainy day will make a building appear quite different to how it appears on a warm sunny afternoon in the summer, Therefore the choice of sky in a 3D model can have quite a significant impact on the way we view a building. Below we can see that by simply changing the type of sky, the effect on the overall visualisation is dramatic.

The most successful sky types are those which do not show the location of the sun. The last two images in the bottom right are the weakest as they indicate the location of the sun and thus create conflict with the shadows on the building.

[33]

Changing the type of sky used can help to show how the building appears during different months of the year. For the architect it not only allows them to see realistically how their design will work year round, but will allow other users to see a representation of a design in all seasons not just in the height of summer. The change in sky type as well as the reduction or increase in the amount of vegetation (depending on time of year) on view will help to create more real world situations for architectural visualisation.

[33] Renders with different sky conditions – C Green

Weathering –

[34]

When you compare both images above it is clear that due to the cleaning of its façade, the Peddie & Browne design looks as new as the Mackintosh 3D model render. Therefore it is safe to assume that had Mackintosh's design won the competition then it too would be in the same condition, with minimal effects of weathering visible.

If one wanted to age their 3D model then a suitable texture could be created which shows the signs of wear and tear. For example the textures below; on the left is the original and on the right the weathered texture. Streaks have been added the colour has been saturated to create the illusion of years of exposure to the elements. The other method of showing age or weathering on a model would be to edit the render in post production using a program such as Photoshop.

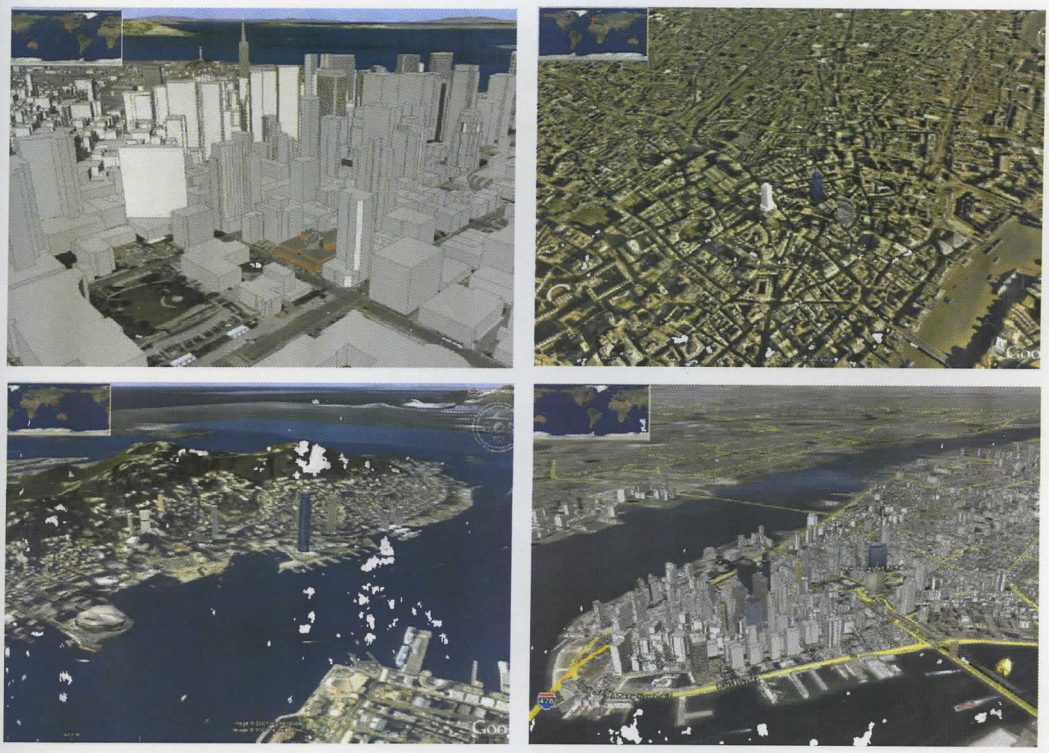
[35]

[34] Left - National Bank of Scotland Today Right – Mackintosh Design
[35] Clean and weathered sandstone textures

Google Earth Comparison –

When Google Earth was first released in 2005 (it had been released a year earlier under the name Earth Viewer by the company Keyhole Inc) it was merely an interactive 3D atlas of the world comprising a series of satellite images which allowed the user to zoom in from space to ground level. However since the takeover of SketchUp by Google, both programs have been linked to allow the placing of SketchUp models into Google Earth. This has allowed any individual to build an accurate model of an existing building and place it into Google Earth, thus allowing for whole cities to be recreated in 3D within a virtual environment. Other information is also present, such as the locations of historical sites and landmarks, as well as roads/street names.

"*Google SketchUp allows you to place your models using real-world coordinates and share them with the world using the Google 3D Warehouse.*"[36]



[37]

[36] http://sketchup.google.com/
[37] Google Earth Images of: San Francisco, London, Hong Kong & New York

Note that different cities have a varying number of buildings created in 3D and to quite different levels of accuracy.

At a cost of £450,000, the Glasgow City Model is an expensive venture. Does the precision gained from such a model justify its cost, and is this increased level of detail needed to compare designs, or could a program such as Google Earth do the job equally as well?

At the moment there is no comparison as Google Earth contains no 3D data of Glasgow other than its terrain, even that data is quite rudimentary, it only shows very basic changes in the terrain. Other cities however, particularly those in America contain a far greater number of buildings which have been recreated in 3D. Though, it has to be said, to varying degrees of accuracy. With the warehouse feature, users can upload their own 3D models for other users to download and use within their own SketchUp models.

Therefore there is great future potential of Google Earth, and there is a case to say that the data collected in the 'Blue Foam' model or even a simplified version of the Glasgow City Model could be incorporated into programs like Google Earth or Microsoft Virtual Earth. Currently at the time of writing Glasgow City Council are looking into placing their 'blue foam' model into Google Earth.

Currently, Glasgow City Council have chosen a program called TerraExplorer to view their 3D 'Blue Foam' model. A slightly unusual choice, due to its relative obscurity when compared to more high profile 3D viewing programs, however as a result, they are able to retain a higher level of copyright control over the model.

At the moment the 'City Model' is the best method for testing new designs in context. The level of testing, which can be achieved through the use of the high detail model is far greater in scope than that which can be achieved with Google Earth or similar. However in the future it should be possible to use said program to achieve similar results to those which can be achieved with the Glasgow City Model.

Conclusion -

The use of 3D models in architecture has grown significantly as technology has improved and more realistic results are achievable. The use therefore of 3D city models will become more commonplace as councils and governments see the potential benefits in town/city planning. The modern architect will therefore be required to become fluent in the software used to create them. Whereas in the past the architect was required to be able to draw in ink and create models from wood and card, the modern architect requires the ability to draw in CAD programs and to model in 3D.

The 3D model has many potential advantages for the architect, in particular with visualisation, but also as a time saving device. Various design comparisons can be made in a relatively short space of time when compared to traditional methods. The use therefore of 3D models allow for a greater level of testing, especially for acoustics, lighting and structures.

3D city models do however have their disadvantages, such as the cost to create them, and the need for the data they contain to continually be updated. They can also be manipulated in a similar way to a perspective drawing, which will often show an idealised view of what in reality could not be achieved. The 3D model always looks brand new and often the choice of sky is not one which would occur in reality, such as a Californian bright blue sky when the building is located in an overcast Glasgow. The final render produced can also be stylised in the same way as a more traditional drawing.

The effects of weathering and pollution on a 3D model are an area in which there is a case for further research. There is also the question of how to populate a model, with people, vehicles, street furniture and trees. The collage element of architectural visualisation is an area within 3D modelling which has yet to be solved. An ideal solution would be the ability to recreate exactly the area around a building, including examples of people in the street vehicles in the street etc.

Further research could also be done into evaluating the potential of programs such as Google Earth. To what level of detail can it achieve, and can it go as far as photorealism?

The National bank of Scotland has provided a good example of the 3D process; from design drawings, to 3D model, and then to city model. The potential benefits have been outlined, in particular those with regards design changes, which can be made quickly to a design such as choice of colour/material or positioning/number of windows on a facade.

All of these elements will allow architects to not only save time but to also make more informed decisions on their designs. The same applies to planning departments who will be able to determine far more easily if new designs integrate well within their surroundings. Members of the public, who currently may not necessarily be familiar with tradition architectural drawings, will be able to have a say on the forming of their built environment. Before and after views for the first time can be compared visually in 3D.

Ultimately the use of 3D models and city models will only be as beneficial as the users want them to be. Glasgow City Council, in this case could have an expensive white elephant on their hands if they fail to fully grasp and make use of the information it can provide. It should allow for better urban architecture and landscaping, as well as allow for greater levels of discussion with the people who live and work in these environments.

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[38] Final Render in red sandstone – C Green

Appendix

Technical Details

Programs -

For all CAD work I used AutoCAD 2007 by Autodesk.

For the 3D Modelling process I used 3D Studio Max version 6 by Discreet (Now part of the Autodesk Company.)

I also used Google SketchUp 6 and Google Earth, for additional modelling.

For the creating and editing of textures and other images I used Paint Shop Pro version 10 by Corel.

Computer specifications -

All CAD/3D Modelling was done on my desktop PC which runs Windows XP:

- AMD Athlon™ 64 Processor 3200+
- 1.5GB of RAM
- 186 GB Hard drive
- ATI Radeon X1600 graphics card

[39]

[39] Glasgow City Model Render – Digital Design Studio

Summary

Technical Details

Software Choice

Future Proof

Jpeg to Dwg –

- Introduction
- Importing a Jpeg file into AutoCAD
- Tracing that image to create an accurate 2d drawing
- Exporting the drawing from AutoCAD
- Alternative Procedures

3D Modelling in 3DS Max –

- Introduction
- Importing the 2d drawing file .dwg
- Modelling the façade
- Modelling the window and doors
- Applying textures to the completed model
- Rendering the finished model
- Alternative Procedures

Software Choice –

The software selected was chosen for a number of reasons. Firstly, AutoCAD was chosen because it is regarded by many as the industry standard for 2d drafting. There are other alternative programmes available however most share the same commands and tools.

The choice of 3D software was slightly different. There are many other programs vying for top place. For example SketchUp has become incredibly popular in recent years, particularly because of its ease of use and compatibility with Google Earth. Other programmes such as Rhinoceros and Maya could have been used, each better at different aspects of modelling. For example Rhinoceros and Maya are better at more organic & NURBS modelling.

However 3DS Max was chosen because of its range of features - particularly when it comes to rendering – and flexibility with other types of modelling. It like AutoCAD is also an industry standard, more so now that the company who previously owned it (discreet) have been taken over by Autodesk, owners of AutoCAD.
This means that file integration has been made far simpler and more streamlined.

"3DS Max is seamlessly compatible with dwg files"[40]

Finally the 'Glasgow City Model' is being built primarily with 3DS Max, therefore integration with the city model should be easier. In the draft notes to be given to architects wanting to place their model in the 'City Model' the Digital Design Studio suggest that:

"The architect's final model should be in a 3DS Max environment." [41]

For image editing there are several options. Photoshop & Paint Shop Pro are probably the most popular choices at the moment. Corel Paint Shop Pro is generally regarded as a more user friendly program than Adobe Photoshop, which has a far greater set of options aimed at the more professional end of the market. The principles however

[40] Spline3d Principle Kevin M. Smith – 3D visualisation Company
[41] Specification for creating models to be imported into the City Model – Draft Edition Digital Design Studio

remain very similar no matter which programs you choose to use, most of the terminology expressed remains the same.

Future Proof -

Both 3DS Max, AutoCAD, Paint Shop Pro & Photoshop have been in existence since the days of Microsoft DOS. Over the intervening years, Microsoft operating systems have advanced and so has the software which runs on it. These programs have been upgraded almost annually to take advantage of new technologies and operating systems. With each upgrade however, the program basics have remained the same with only slight differences which take advantage of new and improved computer and graphics power. As well as advances in the software e.g. improvements in the render engines. Therefore it is safe to assume that in the forthcoming years the basic principles of 3D modelling, photo editing and 2D drafting will stay the same and the processes described will remain valid for several years to come.

Jpeg to Dwg

Introduction -

After deciding to build a 3D model of the National Bank of Scotland, I first got in touch with the Mackintosh curator at the Hunterian Museum & Art Gallery in order to get a high quality image of the original drawing. As far as I can determine from speaking with the Mackintosh curator, this is the only drawing of this scheme, any additional data has either been lost or has yet to be catalogued. Therefore a lot of missing details have to be gained from similar work by Mackintosh.

The reason for converting a jpeg to an AutoCAD file was done mainly for the sake of accuracy; this couldn't have been achieved by merely creating a 3D model directly from the image file in 3DS Max. It was also a personal decision based on previous experience gained on similar projects.

Process -

In order to build a 3D model of the National Bank Building one has to convert a high resolution jpeg into an AutoCAD drawing. With the .dwg file you retain accuracy and scale which are harder to achieve with a .jpeg as the foundation of a model.

To begin with we want to import the .jpeg image of the elevations into AutoCAD. To do this, select *Insert* from the top menu and selected *Raster Image* from the drop down menu. Located the file you want to use and clicked *Open.* The image then appears in the model workspace. The next step was to scale the image so that it would be 1:1, in other words life-size in millimetres. This again helps with the overall accuracy of the drawing.

On the imported drawing Mackintosh has included a scale along the bottom of the drawing. The scale is in imperial measurements and divided into feet and yards. In order to scale the image draw a line in AutoCAD that was one foot in length or 304mm. Then using *the Scale* tool, which is found in the *Modify Toolbar,* or by typing *Scale* into the command box at the bottom of the screen, scale the image so that the scale on the drawing matches up with the line drawn in AutoCAD.

Once complete you should have an image at 1:1 scale. Next, is the process of tracing the image as accurately as possible. Due to the nature of AutoCAD and the image, a few anomalies can occur. The main issue to note is that AutoCAD is a Vector based program. This means that all lines can be scaled to any size without loss of resolution. However the drawing file is a jpeg and is not a vector. This means that if you are zoomed in to a particular area of the drawing and tracing a particular detail, you will notice that the AutoCAD line is much thinner than that of the original drawing, but when you zoom out in appears bigger. In order to avoid this becoming an issue you have to make sure that both elevations meet in key areas. For example, the window sill levels and roof heights should line up in both elevations.

The other issue with tracing the image is that when you zoom in to the drawing a lot of the resolution is lost in the details. This is an unavoidable feature when dealing with a digital image. It is also a problem that couldn't be solved with the original drawings as it was only drawn up to a certain level of detail in ink. As a result some of the details have to be resolved with a degree of artistic licence as well as from looking at similar details in other buildings and drawings by Mackintosh. As it was a competition entry the level of detail which was drawn was limited. Greater detail would have been drawn at a latter stage in the design.

Those issues aside, you can begin to trace the images up to a certain level of accuracy, depending on what you want to achieve in the final drawing. I chose to trace the entire image so that I had the best possible chance of building an accurate 3D model. This was a lengthy process, but in doing it, I was able to complete my 3D model more efficiently. There are also various ways of speeding up the tracing process. For example by making use of the *Copy* command as well as the *Paste as Block* command - both can be found in the *Edit* menu in the top options bar - for repeating windows you need only draw each once then copy the original and *Paste as a block*. The advantage of *Paste as block* is that a window made up of many details, becomes one selectable object rather than several different elements. This improves the editing process as it is easier to select and copy one object rather than several smaller elements. As a result you don't loose lines while repeating multiple windows.

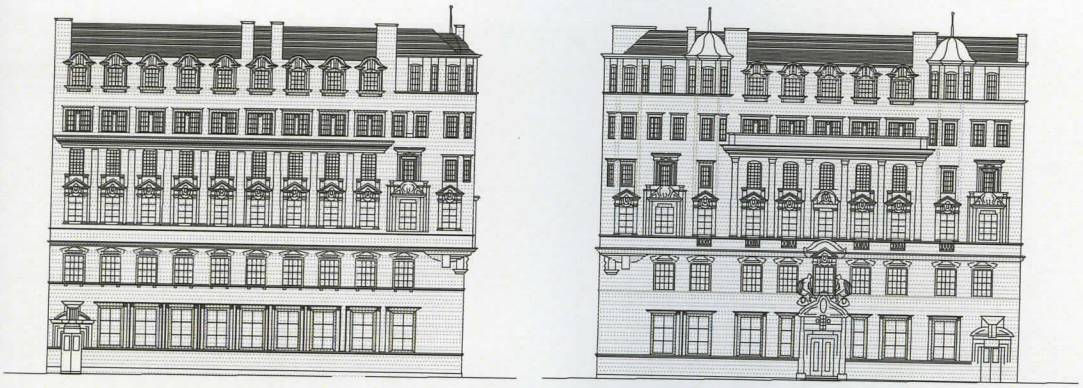
The other key advantage of tracing the image in AutoCAD rather than building the 3D model straight from the image is that you are able to solve parts of the drawing that aren't shown. For example a plan of the roof is unknown; however you can use the elevations to start to understand how it might have worked. The same also applies to interior plans. Though for this exercise I won't be building any of the interior.

Once the tracing is complete, make some final checks of the elevations to make sure they are on the same datum for windows/roof heights etc. Once complete save the finished drawing. An important note on saving a large drawing like this is to save frequently and in a number sequence in case you need to return to a previous version of the drawing. Once the drawing is complete you will be ready to export it into 3DS Max.

When exporting the drawing, it is much easier, if you only export the parts of the drawing you will need for building a 3D model, namely the two elevations. If you export the whole drawing you can end up cluttering your work space in 3DS Max. Therefore the best way to export the elevations is to do so as blocks. To do this first select the whole elevation e.g. the Buchanan Street elevation. Once you have the whole elevation selected click, *Edit-Copy* then *Paste as Block*. An alternative would be to use the short cut command *Control+C* then *Control+Shift+V.* This, as we have seen earlier, means that the elevation is no longer several parts but now just one object. Once you have the elevation selected go to File in the top menu bar and select Export and then choose Block (*.dwg), enter a suitable file name and choose where to save it. As a side note it is easier if you keep all the elements of 3DS Max file together. E.g. all the modelling saves, any textures used as well as the AutoCAD exported files. After you click save AutoCAD will ask you to *Specify Insertion Base Point*, just click on the Block elevation and it should disappear. If you want to retain the elevation block in your drawing click *Control+Z or Edit-Undo* to undo the last action, this wont affect the export of the drawing. You are now in a position to import that file into 3DS Max and begin to model the building.

As a final point with regards the use of AutoCAD in order to trace the image, the number of commands needed is quite few. Almost of the commands can be found in the *Draw* or *Modify* menus. Some of the commands which haven't been mentioned but were used are as follows. The *Arc* command, which is a three point method of creating an arc, the *Spline* command is a free flowing curve for more organic shapes. The *Circle* and *Ellipse*

commands, allow you to create objects with clearly defined dimensions. For editing of the lines use the *Break* and *Trim* commands, finally the *Text* and *Hatch* commands where used however they are not necessary in completing the traced image. In more recent editions of AutoCAD these commands are found within different menus but still work in the same way.



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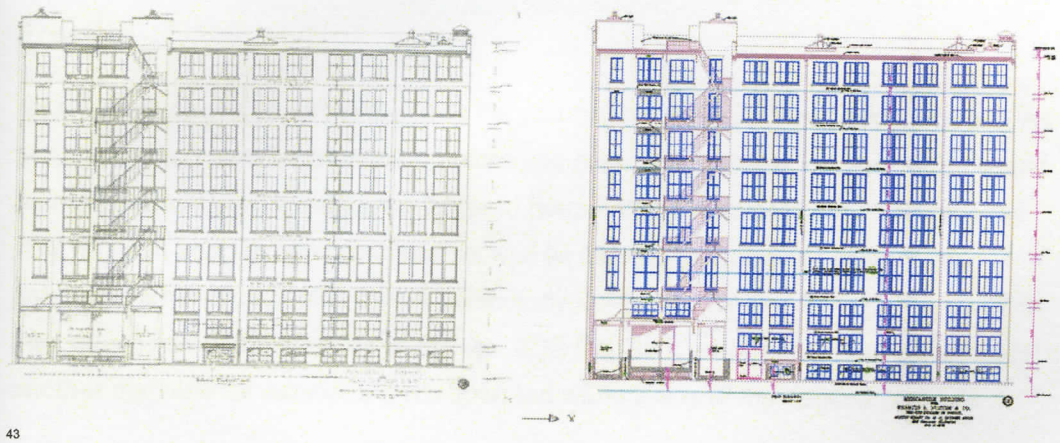
[42] National Bank of Scotland CAD elevations – C Green

Alternative Procedures –

As an alternative to tracing a .jpeg in AutoCAD I could have used a 'Scan to CAD' program or gone to a private company to convert an image to a DWG. Various companies offer this service; and for large organisations, or for multiple drawings it could be a viable alternative to tracing. However, in this case, getting direct access to the original Mackintosh drawing would have been impossible. Even the high resolution image I purchased from the Hunterian Museum & Art Gallery wouldn't have been suitable for scanning due to the condition of the original drawing. Finally, tracing the drawing helps one to get a better understanding of the building, and its details, before trying to model it in 3D.



[43]

[43] Paper to CAD example – Williamson CAD Conversion Services - www.wccs.co.uk

3D Modelling in 3DS Max

Introduction -

Having only learnt 3DS Max recently, I am fully aware of how daunting a program it can appear to be at first glance; with many thousands of options and menus. However most of these will never be needed in the process of making an architectural model; and for the most part can be ignored (the program is heavily designed with animation in mind). It is also worth knowing that even by following a tutorial it can hard to fully grasp the process. With practice however you begin to get a feel for the program and start to learn where certain options are, which are needed and how they operate. There is also normally more than one way of achieving a particular result. It is comes down to personal choice as to which option to take.

Process -

Now that you have exported the .dwg file you can begin the 3D modelling process. As previously mentioned, preparation before you begin is important. To start with I would recommend creating a dedicated folder to house all the relevant saves and textures. This helps to keep things organised as well as helping the program when it goes searching for particular file. This is particularly apt when it comes to textures; as 3DS max doesn't save the textures within the .3DS file. So if you want to open your model on another machine for example, it will open but without any of the applied textures.

Once you open 3DS Max I would recommend saving your file. 3DS Max includes a useful tool when it comes to saving your drawing. When you click *File-Save As* beside the *Save* button there is a small cross +, this allows you to save in sequence without having to rename your file each time. If you save your drawing as 'Bank of Scotland' each subsequent time after when you go to save just click the cross and it will save the file as 'Bank of Scotland 01' and so on. This is important because I have found 3DS Max to be quite unstable at times, and is prone to crashing without warning. It will however, on some occasions allow you to save a recovery file, but this isn't always the case so it's best to save regularly yourself.

Once you have saved your drawing there are a few settings to change before you begin. The first is to set up the units used in the program. To do this go to *Customize* in the top menu bar and select *Units Setup*. Choose *Generic Units* towards the bottom of the box make this change and close the dialogue box. The next change to make is to right click on the magnet icon at the top of the screen. This will bring up *Grid and Snap Settings*. Click on the *Options* tab and change the *Angle (Deg)* to 10, and close the box. To explain the magnet icons; you only really need to use the first two. The first turns the snap on or off and the second turns on the angle snap. The angle snap allows you to rotate an object in increments of 10 degrees each step. This allows for greater accuracy than going by sight only. To turn them on, left click once and you will see the background change from grey to yellow, for the moment only turn on the angle snap, the icon with the magnet and the angle dimension image.

Importing the .dwg -

To start, click *File-Import* from the top menu bar. First change the file type to AutoCAD Drawing (*.dwg, *dxf). Then find the folder in which you saved the exported AutoCAD drawing file, select it and click *Open*. You will be greeted with a box called *AutoCAD DWG/DXF Import Options*. Make sure that *Rescale* and *Hatches* have been deselected and that the *Weld* option has a tick in it, then click *OK*.

Back in 3DS Max you should see in the four viewports your elevation drawing. If you can't, in the bottom right hand corner of the screen click the *Zoom Extents All* button. In the top right hand viewport it should say 'top view' and in this viewport should be the elevation. The first thing you want to do, is rotate the elevation so that it standing upright and not lying on its side. To do this select the elevation and click on the *Rotate* tool in the top menu bar to the left of the snap tools. You should then see three circles; each controls rotation on a particular axis. Blue on the Z-axis, red on the X-axis and green on the Y-axis. Click on the red X-axis (it will turn yellow when selected) and drag it down until 90 appears in the text above. Your elevations are now facing the correct way. In the 'front viewport' in the top right hand corner, the elevation drawing should appear. You are now ready to start the modelling process.

By default in 3DS Max there are four different viewports; top, front, left and perspective. If you want to change the viewport layouts right click the top left hand corner of one of the viewports. For example right click where it says 'top' and a dropdown menu will appear. Select *Configure* which is at the bottom of the list and a dialogue box will appear called *Viewport Configuration*. Select the *Layout* tab and choose your desired configuration of viewports. When you become more proficient with modelling you may find that only two viewports are needed. For the most part of this tutorial I used only the perspective and top viewports.

Modelling -

In 3DS Max there are several ways of modelling, Primitive, Shapes and Splines, Polygons, Meshes, Patches, NURBS, Compound Objects and Particle systems. For the purpose of this description I will be using *Polygon Modelling*. This method allows you to edit the vertexes, edges, borders and polygons of a given object. The reason I have chosen to model this way is because a building tends to be made up of a series of geometric shapes, polygon modelling allows you to do this quite efficiently. It isn't however as effective when modelling more complex or organic shapes. For more organic shaped models using Shapes & Splines would be more appropriate. However there isn't a hard and fast rule when it comes to choosing, it is very much up to personal choice. In order to model the elevations I am going to edit box shapes in order to create windows, doors and mouldings and other details. Each of the building elements are going to be modelled separately then joined together later. This allows the 3D model to be refined and polygon numbers reduced, so that it isn't as demanding on your computer when it comes to rendering.

Façade Modelling –

To begin, I will model the main structure of the elevation, the brick façade. Once this is finished I will punch holes into it using the *Boolean* command for the window and door frames. To begin, select *Box* from the *Standard Primitives* in the *Create* panel on the right hand side of the screen. At this stage I will explain in some detail how to create the brick shape for the main part of the façade. After selecting the box command turn on the snap option at the top of the screen. Then in the 'perspective view' left click on the bottom corner of the Buchanan Street elevation and drag a box the full length on the building. Then drag in the opposite direction to give in depth. If done correctly you should have a long cuboid that stretches the length of the building but is only as high as a brick. Select the box and go to the modify panel next to the create panel where it says box right click on it and select *Editable Poly*. This converts a standard box to an editable polygon. As a box you can only change the height, width and length. As a polygon you can edit a greater number of elements, such as its corners and edges. In order to change the cuboid into a brick shape you have to *Chamfer* its edges. To do this, select

the box and in the *Modify panel* and click on the *Edge* command. This will allow you to pick the edges of the box. In the perspective view you can left click on the different edges. You can then apply all sorts of changes to them. In this case I want to edit two of the box edges, the top and bottom edges on the street side. To do this, return to the *Modify panel* and select the *Chamfer* tool which appears in the *Edit Edges* drop down menu. Select *Chamfer* and you can either input a value or chamfer manually. In this case I will input a value, to do this click on the small box beside the *Chamfer* command and a dialogue box called *Chamfer Edges* appears. There is an option to put in a value of chamfer amount in this case I want a chamfer of 1 unit. Click *OK* and return to the perspective viewport you will then be able to see that the edge has become two instead of what was previously one corner edge.

Now I want to repeat the brick façade the full height of the building. To do this I could use the *Array* command under *Tools-Array* in the top menu bar. However in this particular case particular case I am going to use *Copy and Paste* commands. However unlike in AutoCAD I will do it by holding down the *Shift* key while using the *Select and Move* command. Therefore in order to duplicate the brick object I will select the *Move* tool from the top menu bar beside the *Rotate* tool and select the brick object that I have just chamfered. Just like the *Rotate* tool the move tool lets you move an object on three axes; each is defined by three coloured arrows rather than circles indicating a particular axis. If I select the brick shape and move my cursor over the bottom corner by then holding down the shift key and dragging upwards I can *Snap* the duplicate brick on top of the original. This technique of duplication is a useful when it comes to making several identical windows along a known datum. By holding down *Shift* and dragging along a particular axis you can create as many copies of a particular object as you want. That aided by the *Snap* tool can make building an identical section of wall quite easy. A note at this stage is that if I had wanted I could have created a flat façade and created a brick texture to be applied onto that object. I this case however I wanted to get the real effect of brickwork on the model, this will increase render times but will result in a more realistic final render, particularly when it comes to the lighting of the building.

Once complete you should have a wall the height of the building. The next step is to punch holes in the facade for the window and door frames. To do this look at the 'front viewport', you should still be able to see the underlying drawing through the newly created brick wall. If not right click where it says *Front* in the top left hand corner and

select *Wireframe* from the dropdown menu. Now select the *Box* command from the *Create Panel* as described earlier. This time drag a box so that it fits in the space where the window would sit. If the snap is still on it should make that job easier. Then go to the *Modify Panel* and make sure the box is wide enough to cut through the brick wall. This can be confirmed by looking in the 'perspective viewport' and by using the *Arc Rotate* tool (found in the bottom right hand corner of the screen along with the other viewing commands) look in 3D around the model. You then want to repeat this process until all the window and door openings have a box in them. Then to make things easier and less time consuming when in comes using the *Boolean* command, you want to attach all the boxes together as one object. To do this select one of the boxes and go to the *Modify Panel* and convert the box to an *Editable poly*. Then under the *Edit Geometry* command select *Attach*. Select all the remaining boxes by left clicking on each once. You should then have a group of boxes which are now one object rather than several. Next do the same for the brick wall so it is one object. Select the brick wall and in the *Create panel* select *Compound Objects* from the dropdown menu. Select the *Boolean* command and under operation make sure *Subtraction (A-B)* is selected. As a side note, *Boolean* can be used for a variety of cutting and joining operations, such as union, cut and intersection. Further down the menu there is the option to *Pick Boolean*, click the button below which says *Pick Operand B*. Then select the box object group. Once selected the box group should have disappeared and you should be left with a series of holes cut from the brick façade wall. Once done select the façade wall and in the modify panel where it should now say *Boolean,* right click and change it back to editable poly.

Window & Door Modelling -

Now that the main body of the façade is complete you can start to add the details. Window and door modelling follows a similar pattern to that of the façade. However as the various elements get more complex in design, more commands are required to model them accurately.

The process of modelling a window starts of in the same way as the façade. Start by selecting *Box* from the *Create panel*. Drag a box from the middle of the window to its edge and drag out a suitable depth using the necessary snap tools. At this stage it is important to note that it is unclear from the elevations, how far out from the façade the windows and doors would have extended. It is therefore at this point, that judgement

based on similar design elements is used. As part of this process I collected a series of images showing examples of other Mackintosh proposals. This included images of completed works as well as design details of buildings that were never built, in order to get a better idea of how these elevations would look if built.

Once you have completed the box, convert it to an *Editable poly*. Then within the same menu click on the *Modifier List* dropdown and select *Symmetry*. As most window and door designs have a line of symmetry running down the centre it is more efficient and practical to only actually build one half, and mirror the other side. If you click the *Show End Result on/off toggle* you can see both sides of the window at the same time, at this early stage however it is not entirely necessary. Now in order to build up the window you will start to use other commands within the *Modify Panel*. To start with we have a simple box shape, which is the lower part of the window. Next we want to *Extrude* part of the top polygon so that we have the side of our window. To do this we need to split the top polygon of the box. To do this go to the *Modify Panel* and select the *Vertex* command, then lower down the same menu select *Slice Plane*. The *Slice Plane* allows you to make a series of cuts in an editable polygon which divide the particular faces. Right now we want to split the top face to allow an extrusion to take place. Once you have selected the *Slice Plane* a yellow rectangle will appear around the box. A similar tool *Cut* also creates new vertices but only on one polygon at a time. This plane can be moved and rotated by the relevant commands in the top menu bar. In this scenario we want to rotate it 90 degrees and move it slightly to the right.

When you have the plane in the desired location, click slice. If you are still in vertex mode you will see several new vertices have been created. In the *Modify Panel* select polygon and click on the top face. You will see that where there was once one face there are now two. Select the furthest right of the two, then from the menu below select *Extrude*. Like most of the tools in 3DS Max you can either input a value or *Extrude* manually. In this case, we will *Extrude* manually. Return to the 'front view' and with the *Extrude* command drag the face upwards to its desired height. When using a tool such as extrude you will notice that when you move your cursor over a highlighted polygon, the type of cursor will change; thus indicating that a new command is active. Sometimes you will have to reselect a polygon after you have changed viewports. If this happens

you can click *Control+Z* once to undo which reselects the previous polygon allowing you to proceed with the extrude command in a new viewport.

You should now have two sides of the window making an L-shape. We now want to take another horizontal extrusion to make the top like the bottom. There are a couple of ways of doing this, you could either make another cut in the object with the *Slice Plane* or duplicate the lower horizontal part of the window. To do this, select polygon from the *Modify Menu* and left click and drag the lower part of the window. Make sure at this stage that *Ignore Backfacing* is deselected because if it isn't you will only select the polygons that are visible. Once selected, select the move tool and hold shift and drag up. If you still have snap on the corners of the horizontal and vertical elements should join automatically. If not, a bit of fiddling might be required to get them to join properly. Once complete return to the *Modify Panel* and select vertex. Left click and drag a box round all the vertices turning them from blue to red. From the same menu select *Weld* but instead of clicking on the *Weld* button directly click the small box beside it. A dialogue box will appear telling you the number of vertices that exist and how many there will be after you *Weld*, click apply. The *Weld* command helps to remove unnecessary vertices that may have appeared after joining or slicing operations.

The next stage is the creating of the cornice that appears at the top of the window. To achieve this we use a combination of the *Extrude* command on polygons, and the *Move* command on the vertices. For this sort of modelling, the use of different viewports is quite important. The front and top viewports are very useful, particularly, as the perspective view can be deceptive when moving vertices. For example, you may think an object has snapped to the correct point but when viewed in another viewport you can see that it snapped to something else. Expanding on this further; it is important to learn when to turn snaps on and off because more often than not they can more of a hindrance than a benefit.

The 'front view' is used to trace the elevation imported at the beginning, while the 'top view' is used to make sure the right vertices are being selected. In order to create the shape of the cornice you have to move vertices and polygons on all three axes. To begin we would *Extrude* the top polygon of the window upwards until it meets the first horizontal which indicates a change in the surface. In this example that change would be

the increased depth of the cornice as it begins to move further away from the façade. To achieve the outward curve of the cornice *Extrude* again the polygon so that you have created a new set of polygons. Then go to the 'left viewport' and select the top most vertices on the side farthest away from the façade. Then after making sure that *Ignore Backfacing is off*, use the move command to pull the vertices away from the window. What you should see in the 'left viewport' is the vertical line of the window and at the top an outward diagonal shift. The method of extruding polygons, and moving vertices, is the basic technique used in order to create windows, doors and other ornamental elements. If you want to create more of a curve than a diagonal then work through the same process but take more incremental steps. As a point of caution the more polygons and vertices created the longer the render time and file size. To reduce this you can deleted those polygons that will not be visible once the model is complete. An example of this would be the back polygons of the window which sit flush against the façade.

At this stage in the modelling process it is a case of repeating the above process for all of the façade details. A couple of other commands of use are *Inset* and *Bevel*. Both of these can be found in the *Modify Panel* beside the *Extrude* command. The *Inset* command allows you to create for example a rectangle within a rectangle. Thus if you want to create a photo frame, you would create a box, convert it to an editable polygon and *Inset* it inwards to create the internal rectangle. Like most other commands in 3DS Max you can either do this manually with the cursor, or by inputting a set value. The *Bevel* command does the same thing as *Extrude* by letting you move a surface in or out but instead leaving a square edge it lets you *Bevel* the corners, like you can do on edges with the *Chamfer* tool. An example of this would be the indentation found on the top and bottom of bricks.

Textures -

Texturing in 3DS Max can appear quite a daunting task when you first set eyes on the Materials dialogue box. This can be achieved either by pressing the *M* on the keyboard, or by going to the top menu bar and selecting, *Rendering-Material Editor*. Once selected you are greeted by the Material Editor dialogue box. At the top there are a series of grey circles (material slots) and below there are several dropdown menus with titles such as *Shader Basic Parameters* and *Blinn Basic Parameters*. The important aspect to bear in

mind at this stage is that all these menus are used for creating new textures or editing existing ones. For example you can change the colour, glossiness or the opacity of a texture. An example might be the coloured metal of a car. These options allow you to define how reflective or shiny the texture is. All these tools and options enable you to create a realistic texture. The other method of texturing is to import an image file such as a jpeg, and then pasting it onto a surface. This method would be used if you wanted to apply a brick, wood or carpet texture to an object. 3DS Max comes with a small selection of textures however if you want a wider selection then you can buy texture CDs, download them from the internet or by making your own from photographs. At the Digital Design Studio where they are building the 'Glasgow City Model' they created custom textures for the cities buildings from high resolution photographs taken when they are on site surveying.

To import a texture to 3DS Max you select the small grey box which sits across from diffuse option in the *Blinn Basic Parameters* dropdown menu. By clicking on this box a new dialogue window opens called *Material Map Browser*, there are several options listed but the one we are interested in is *Bitmap*. If you double left click on bitmap a new dialogue window opens, Select *Bitmap Image File*. You are then able to search for an image file, when selected click open. Once opened, the image should appear the top right material slot. It will look slightly odd at this stage as it has been applied to a sphere and is warped. This however has no effect on the texture when you come to apply in to an object or surface. In order to apply this texture to a given object, you must first select the object in 3DS max then return to the material browser and click the button, *Assign Material to Selection*. This is a small icon directly below the material slots, and looks like a blue circle with an arrow pointed to a cube. The object selected for texturing should now turn a shade of grey. In order to see the texture in 3DS Max, click the *Show Map in Viewport* box, this icon sits to the right of the *Assign Material to Selection* box. The icon looks like a blue and white checked cube. In your viewport you should see the texture on the object. However it will probably be distorted; this is because the texture is 2d yet the object you are applying it to is 3D dimensional. To fix this problem you can either apply the texture to a single polygon rather than the whole object, or apply what is called a *UVW Map* to the object. A *UVW map* is a 3DS Max coordinates system for texturing an object. To apply a *UVW Map* select the object you want to texture and in the *Modify Panel*, under the *Modifier list* scroll down to the bottom and pick *UVW Map*. You will then

see a series of parameters, which change how a material is applied to a given surface. If you are applying a texture to a cuboid shape for example choose box. There are further options for face (single polygons) and cylindrical and spherical *UVW Maps*. The options below such as length width and height as well as *U tile*, *V tile* and *W tile* allow you to make slight variations to how the texture sits on the object. For example it allows you to stretch a texture in a particular direction or to tile the texture if it isn't quite to scale on the object. This is quite a tricky process that will require repeating for almost every texture on a model; very rarely will a texture be applied that sits perfectly to scale on a given object.

This is just a basic introduction to applying textures. Like all aspects of 3DS Max there is an incredible number of options which can be altered to try a give a particular end result. Due to the nature of the model I am building I will use fairly basic texturing, as most of the detail will be within the model itself. However for areas such as the stained glass in the doors I will create some suitable textures to be applied. A tile texture for example, would be useful for the roof say; rather than trying to model all of the individual tiles.

Rendering -

Now that you have a completed/textured model you are able to begin rendering your image. Again as we have seen before there are numerous options within 3DS Max when it comes to rendering your model; too many altogether to try and explain so I will outline a basic method for lighting and rendering your model.

First we need a light source with our scene. To create a light go to the create panel and select the *light* icon. There are several different options to choose from such as *Target Spotlight, Omni, Free Spotlight and Skylight*. For the purposes of this description select *Skylight* and left click to place it anywhere within the viewports. The *Skylight* isn't affected by scale or location as it creates a general light level all over your model; similar to daylight on an overcast day without a visible sun. Once you have placed the skylight in your model/scene, press *F10* or *Rendering-Render* from the top menu bar. This brings up the *Render Scene* dialogue box. At this stage we also want to look at the environment effects so either click, the number *8* or *Render-Environment* from the top menu bar. The *Environment and Effects* dialogue box gives options to do with setting the background colour or image as well as different exposure options which can be applied to a render. By default all renders have a black background in the *Environment and Effects* box you can change the colour or import an image to act as the background. This

could be a jpeg image of the sky or the landscape in which your building is situated. This is called the *Environment Map* and can be selected in the same way as textures. For this example we will leave all the options as default.

Close the *Environment and Effects* dialogue box and return to *Render Scene*. At the top there are five different options tabs at this stage we will only be using two; *Common* and *advanced lighting*. First click on *Advanced Lighting* from the dropdown menu select *Light Tracer*, this will present you with a series of different options regarding; number of *Skylights*, number of rays and number of light reflections or bounces. Leave all as default and return to the *Common* tab. Within this tab we can alter the dimension size of the render, the type of render file for example an image such as a jpeg or movie file such as a .mov or .avi file type. Leave everything as default select the perspective viewport and click *Render* in the bottom right hand corner of the *Render Scene* dialogue box. A new window will appear showing the render process. Within this window are the options to save the finished render to disk, view different colour channels or delete the image. Once complete, save your finished render and close the render window.

Render Times -

The time taken to render a model can vary enormously, from a few seconds to several hours. The render time is effected by how complex your model is, e.g. the number of polygons. Or by the type, and number of lights in use in a scene, e.g. the more lights in use mean more rays, more reflections etc.

The speed of the machine being used also has an effect; the type and speed of the processor/graphics card and amount of RAM in the system all contribute towards the render times. As a rule of thumb, the more photorealistic you want your render to be then the longer it will take to complete. For quick/test renders, most rendering software allows a quick render or preview render to take place. Some will even allow the rendering of a specific area of your model. This enables the user to see the effect of model or lighting changes, without having to render the model as a final image and thus saving time.

[44]

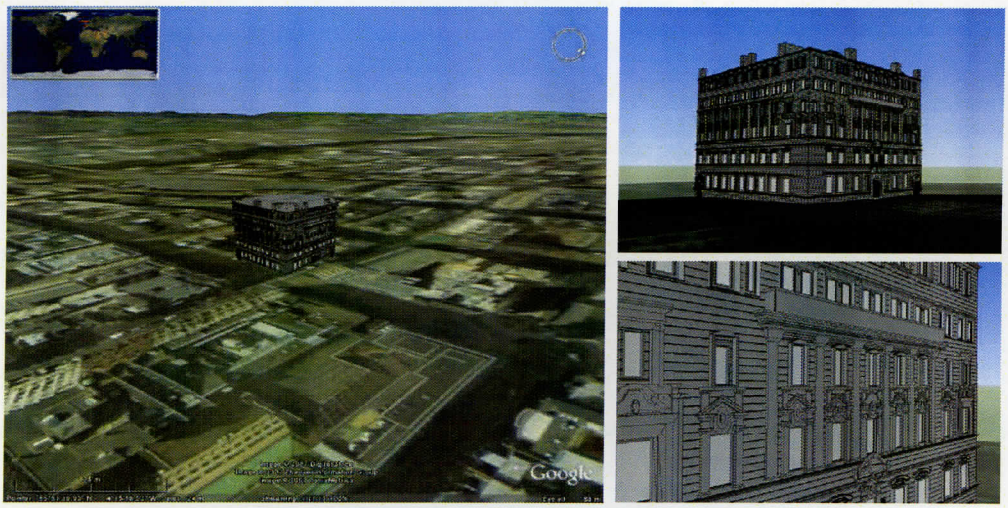
[44] National Bank of Scotland Greyscale Render with Highlighted Bank – C Green

Alternative Procedures –

As stated earlier, the method I have chosen is just one of several possible options. However due to the fact that I want a finished 3DS MAX file then it makes sense to complete the modelling in that program. However most 3D modelling programs are fairly interchangeable with regards file types; this means that a model can be created in one 3D modelling program and exported into another. As an example I will explain how this can be achieved in SketchUp 6.

SketchUp -

Once you have created your model in SketchUp, select the entire model by using *Control+A* or from the *Edit* menu. Once selected go to *File-Export-3D Model* and select *.3DS* from the dropdown menu. Once complete open 3DS MAX and select *File-Import,* and open up your newly created *.3DS* file. A dialogue box should appear asking you whether or not you want to change the units of the incoming file or to merge the incoming model with the existing scene or replace the existing scene. Select replace, and click ok, your SketchUp model should now be selectable within 3DS MAX. This method works in the opposite direction as well; from 3DS MAX to SketchUp, however there are a few more options which have to be selected to do so. This procedure is useful if you want to place your 3D model into Google Earth as there is a direct link between both programs.



[45]

[45] National Bank of Scotland – un-textured in Google Earth

Glossary of Terms -

Render – The process by which colour and shadows are given to a model. Normally resulting in a 2D image such as a jpeg or a movie file such as an .avi

Skylight – A type of light in 3DS Max which gives a uniform light, an overcast sky

Light Tracer – A type of light source in 3DS Max which gives a soft edged shadows used for bright outdoor scenes

Environment Map – An image file used to represent a sky/background in 3DS Max

Omni Light – A type of light in 3DS Max which casts light rays in all directions from a single source

Free Spotlight – A type of light in 3DS Max which gives a single source of light in a particular direction (like a torch).

Target Spotlight – Same as Free Spotlight but with a target

Snap – A tool in 3DS Max and AutoCAD which helps in the joining of two points exactly together

Trim - A tool in AutoCAD used for altering the length of lines

Extrude – A tool in 3DS Max which allows the user to create extrusions to a surface

Bevel – A tool in 3DS Max which is a combination of Extrude and Chamfer, an extrusion with chamfered edges

Inset – A tool in 3DS Max which creates a new polygon within an existing one, e.g. a smaller rectangle within a larger one

Chamfer – A tool in 3DS Max which bevels an edge

Viewport – in 3DS Max, a window displaying a particular view. In AutoCAD a window between Model Space and Layout tab.

Bitmap (.bmp) – A type of image file made up of a series of dots arranged in columns

Jpeg – a compressed image file, smaller in size than a bitmap

Dwg – the standard AutoCAD drawing file; DraWinG

Dxf – A CAD drawing file which can be used in a variety of CAD/3D programmes

Spline – a free flowing line type in both 3DS Max and AutoCAD

Break – A tool in AutoCAD used to separate an object

Scale – A tool in both AutoCAD and 3DS Max used to increase or decrease the size of an object by a percentage value

Raster Image – An image like a bitmap, which is hard to modify without loss of information

Vector Image – An image file which doesn't loose information when scaled

Texture – A type of image file used to represent a particular surface e.g. concrete

Copy & Paste – A method for duplicating an object

Wireframe – A way to view a 3D Model which only shows the edges

Arc Rotate – a tool in 3DS Max which allows an object to be moved on three axes XYZ

Polygon – A rendered surface in 3D modelling usually, but not always with three sides made up of vertices and edges

Boolean – A tool used in 3DS Max to create cuts or joins into objects, for example Union, Subtraction, Intersection and Cut

Box – A primitive object in 3DS Max

Symmetry – A command in 3DS Max which allows only half a model to be built and the other mirrored across

Cut – See Boolean

Vertex – A point/node in a 3DS Max object

Slice Plane – A 3D plane used in 3DS Max for creating cuts in objects

Weld – A command in 3DS Max used to join vertices together

Backfacing – The hidden polygons in 3DS Max which can or cannot be selected depending on whether the option is on or not

Move – A tool in AutoCAD and 3DS Max which allows a object to be moved around the drawing/model space

Import/Export – A method for moving a drawing or model between different programmes

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